



**University of  
Zurich**<sup>UZH</sup>

**Zurich Open Repository and  
Archive**

University of Zurich  
University Library  
Strickhofstrasse 39  
CH-8057 Zurich  
[www.zora.uzh.ch](http://www.zora.uzh.ch)

---

Year: 2014

---

## **Lobbying and the power of multinational firms**

Polk, Andreas ; Schmutzler, Armin ; Müller, Adrian

**Abstract:** Can multinational firms exert more power than national firms by influencing politics through lobbying? To answer this question, we analyze the extent of national environmental regulation when policy is determined in a lobbying game between a government and a firm. We compare the resulting equilibrium regulation levels, outputs and welfare in a game with a multinational firm with those in an otherwise identical game with a national firm. For low transportation costs, output and pollution of a national firm are always as least as high as for a multinational; this changes for high transportation costs and intermediate damage parameters. When there is no lobbying, welfare levels are always higher with multinationals than with national firms. However, the existence of lobbying may reverse this ordering.

DOI: <https://doi.org/10.1016/j.ejpoleco.2014.07.010>

Posted at the Zurich Open Repository and Archive, University of Zurich

ZORA URL: <https://doi.org/10.5167/uzh-105200>

Journal Article

Accepted Version

Originally published at:

Polk, Andreas; Schmutzler, Armin; Müller, Adrian (2014). Lobbying and the power of multinational firms. *European Journal of Political Economy*, 36:209-227.

DOI: <https://doi.org/10.1016/j.ejpoleco.2014.07.010>

# Lobbying and the power of multinational firms

Andreas Polk<sup>a</sup>, Armin Schmutzler<sup>b,c,\*</sup>, Adrian Müller<sup>d</sup>

<sup>a</sup> *Berlin School of Economics and Law, Badensche Str. 50-51, 10825 Berlin, Germany.*

<sup>b</sup> *Department of Economics, University of Zürich, Blümlisalpstrasse 10, 8006 Zürich, Switzerland.*

<sup>c</sup> *CEPR, London U.K.*

<sup>d</sup> *Institute for Environmental Decisions, ETH Zürich, Universitätstrasse 16, 8092 Zürich, Switzerland.*

July 21, 2014

## Abstract

Can multinational firms exert more power than national firms by influencing politics through lobbying? To answer this question, we analyze the extent of national environmental regulation when policy is determined in a lobbying game between a government and a firm. We compare the resulting equilibrium regulation levels, outputs and welfare in a game with a multinational firm with those in an otherwise identical game with a national firm. For low transportation costs, output and pollution of a national firm is always as least as high as for a multinational; this changes for high transportation costs and intermediate damage parameters. When there is no lobbying, welfare levels are always higher with multinationals than with national firms. However, the existence of lobbying may reverse this ordering.

*Keywords:* Multinational enterprises; Regulation; Pollution; Policy formation; Lobbying; Interest groups; Foreign direct investment

*JEL classification:* D72; F23; L51

---

\*Corresponding author. Department of Economics, University of Zürich, Blümlisalpstrasse 10, 8006 Zürich, Switzerland. Tel.: +41 44 634 22 71, E-mail address: armin.schmutzler@econ.uzh.ch.

# 1 Introduction

Even though global foreign direct investment has faced two major negative shocks since the turn of the century, the stock of foreign capital in most countries is much higher than several decades ago. Some authors argue that the influence of lobbying on the political process has grown due to this aspect of globalization. This perception sometimes culminates in the notion of the 'loss of sovereignty' of the nation state. According to this view, national governments lose their discretion to set policy, e.g. environmental regulation, because multinational enterprises have a better lobbying position vis-à-vis governments than national firms: the former can relocate in response to unwanted policies, and governments that want to avoid such relocation must succumb to the wishes of the multinationals. In this fashion, a race to the bottom ensues when multinational firms are important, leading to 'pollution havens' with excessively lax regulation to attract multinational firms. Contrasting this view is the 'not-in-my-backyard' (NIMBY) story: If pollution causes high damages, governments may set inefficiently high pollution standards to deter polluting multinationals.

Such motivated, we ask whether the growing importance of multinational firms indeed leads to harmful policy biases and, in particular, whether it leads to lax pollution regulation. We focus on a small country that has to take environmental regulation in the rest of the world as given. Our framework applies to the interaction of industrialized countries with transition economies and LDCs, or to cases where some industrialized countries decide to introduce stricter environmental regulation than others due to national preferences.<sup>1</sup>

We analyze how such countries set their regulation when they face a footloose ("multinational") monopolist that can choose where to set up its production facilities. The monopolist can engage in lobbying activities to influence regulation. To bring out the role of a footloose firm's ability to freely choose locations, we compare the outcome with the one that would emerge with a "national" monopolist that is restricted to produce in its home country. While there is no general result that multinational firms are regulated more or less heavily than national firms, we can determine the circumstances under which each case emerges.

---

<sup>1</sup>For instance, in contrast to European countries and Australia, the United States never ratified the Kyoto Protocol and Canada recently withdrew from it for fears of unemployment and negative economic effects. Also, countries follow divergent national regulatory approaches towards the use of nuclear energy. Regulation in France is rather lax and allows for exports to third countries, whereas Germany's approach has traditionally been stricter, culminating in the recent decision to phase out nuclear energy production.

More specifically, we consider a stylized three-stage game.<sup>2</sup> In period 1, the small-country regulator who maximizes political support chooses the level of a pollution standard that raises unit costs. In period 2, the monopolist chooses between three options: produce exclusively from the home country (“no relocation”), open a plant in the foreign country as well (“partial relocation”); close down production in the small country altogether (“complete relocation”). In period 3, the monopolist chooses quantities on the two markets. International trade is allowed, but subject to trade or transportation costs.

We determine all equilibria of the game. Our central results (Propositions 1 and 2) provide a complete characterization of the equilibrium regulation and the resulting location patterns for the multinational firm as a function of the main parameters (environmental damage, transportation costs and the weight of the firm in the political support function). If the firm weight increases and potential environmental damages decrease, regulation changes in such a way that the equilibrium moves from relocation to partial relocation and finally to no relocation. For very low transportation costs, regulation induces complete relocation (with imports from the foreign country), whereas, for high transportation costs, it induces only partial relocation (where both markets are served locally).

We use the equilibrium characterization to illustrate how the regulation of multinational and national firms differs, and how lobbying affects the difference. As a first benchmark case, we follow the related literature (see Markusen et al. 1995; Rauscher 1995) and assume that the regulator applies a consumer standard. Thus she cares only about consumer surplus and environmental damage, not about producer surplus – in particular, her behavior is not affected by lobbying.

In this benchmark case, whether the national or multinational firm produces and pollutes more in the home country depends on transportation costs and the environmental damage parameter. For sufficiently low transportation costs, the output of the national firm is never lower than the home country output of the multinational firm, and for wide parameter ranges the output of the national firm is higher. For high transportation costs, the picture is reversed when environmental damages are at intermediate levels: The multinational firm produces and pollutes more in the small country than the national firm.<sup>3</sup> Nevertheless, in the benchmark case without firm influence

---

<sup>2</sup>The underlying location game is related to Motta and Thisse (1994) and Markusen et al. (1993, 1995); see Section 2 for more details.

<sup>3</sup>Essentially, imposing strict regulation has greater environmental benefits with a national firm than with a multinational firm. For high transportation costs, the multinational firm does not export to the foreign country, so that regulation only affects pollution re-

consumers are always better off with multinational firms than with national firms: Welfare, defined as consumer surplus minus environmental damages is always higher.

With a positive weight of producer surplus in the regulator's objective function, this no longer is true. It is straightforward that lobbying leads to weaker regulation with national as well as multinational firms. More surprisingly, there are two striking results. First, the parameter region where the multinational produces higher output and pollution corresponds to higher values of the equilibrium damage parameters, that is, to more damaging pollution. Second, for more dangerous pollutants and sufficiently high transportation costs, welfare can be lower with a multinational firm than with a national firm when the profit weight is sufficiently high.

In the main text, we analyze a monopoly model with specific functional forms for demand, costs, environmental damage and the type of regulation. In the appendix, we then derive the most important insights of the specific model in a more general set-up. It turns out that neither the specific functional forms nor the assumption of monopoly markets are necessary for the main results.

After a discussion of related literature in Section 2, Section 3 describes the model. Section 4 derives the locational choices of firms for given regulation levels. In Section 5, we characterize regulation for national and multinational firms, respectively. Section 6 compares regulation levels in the two cases, and it shows how lobbying affects the comparison. Section 7 deals with welfare issues. In Section 8, we discuss the robustness of our results, in particular, by reference to a more general model analyzed in the appendix. Section 9 concludes.

## 2 Related literature

Our paper combines two strands of literature.

First, it belongs to the vast literature on lobbying. Hillman (1989) and Grossman and Helpman (2002) provide surveys of different lobbying approaches and how they are interrelated.<sup>4</sup> In our model, the regulator maximizes a weighted average of consumer and producer surplus. In this respect, the paper builds from the political support function approach (Peltzman 1976).<sup>5</sup>

---

sulting from production for the home country. For the national firm, however, regulation also curbs pollution resulting from exports to the foreign country.

<sup>4</sup>Potters and Sloof (1996) provide a survey with an empirical focus.

<sup>5</sup>As shown for instance by Grossman and Helpman (1994) such a regulatory behavior

Within the lobbying literature, our paper is most closely related to several papers that deal specifically with lobbying activities of multinational firms.<sup>6</sup> Lobbying of multinational firms has mostly been analyzed in the context of endogenous trade policy, under the assumption that the location choices of firms are exogenous. For instance, Hillman and Ursprung (1993) analyze trade protection in a model with a given number of firms, an exogenous share of which are multinational. If the share of multinationals increases, protection declines. This effect reflects a change of lobbying incentives of national firms. With increasing competition from multinationals, domestic producers benefit less from trade protection, which reduces their incentives to lobby for it.<sup>7</sup> Another strand of literature focuses on the effect of lobbying by domestic producers if multinationals may circumvent trade barriers. For instance, Grossman and Helpman (1996) analyze domestic lobbying for protection if multinational firms anticipate the political lobbying outcome and decide to export to the foreign country or invest to circumvent trade protection. In their model, multinationals do not lobby, and the decision to invest abroad results from a tariff-jumping motive.<sup>8</sup> Empirical studies indicate that foreign and multinational firms influence the political process. Even though the extent of lobbying tends to be smaller for multinational than for domestic firms, the former have a significant effect on domestic politics (see Gawande et al., 2006; Hansen and Mitchell, 2000).<sup>9</sup>

---

can result from a lobbying game in which interest groups offer contribution payments to an incumbent government. The government deviates from the welfare maximizing policy in exchange for contributions.

<sup>6</sup>We restrict the small overview to literature which analyzes lobbying in the context of multinational firms. Another strand of the literature analyzes lobbying against environmental regulation. For instance, Fredriksson and Wollscheid (2008) analyze how lobbying influences investments in abatement technology. In the context of trade theory, Schleich (1999) analyzes the interaction between lobbying against environmental regulation and lobbying for trade protection. In his model, the market structure is exogenous and plant relocation does not occur as a consequence of strict regulation. Sturm (2003) provides a survey of the literature.

<sup>7</sup>Recent contributions on lobbying of multinationals are Stoyanov (2009), Gawande et al. (2006) and Konishi et al. (1999). Aidt and Albornoz (2011) analyze lobbying efforts of multinationals directed at protecting investments against taxes or other expropriation measures abroad.

<sup>8</sup>This idea is closely related to the literature on 'quid pro quo' investments, where multinationals invest in a foreign country to defuse the threat of protection abroad (see Bhagwati, 1987; Bhagwati et al., 1992).

<sup>9</sup>More broadly related, in a contribution with an empirical focus, Fredriksson et al. (2003) assess how lobbying and corruption of state employees affect environmental regulation and inbound FDI into the United States. In their model, the allocation of capital is endogenous; workers and environmental groups lobby for environmental regulation whereas capital owners do not.

Second, our paper belongs to a literature that analyzes the interaction between environmental regulation and firm locations under increasing returns to scale. Even though early empirical research found it hard to confirm a relation between regulation and location, recent contributions provide evidence that regulation has an impact on the location decisions of firms (see Brunnermeier and Levinson, 2004; Levinson and Taylor, 2008). Theoretical contributions analyze whether the ability of multinationals to relocate production leads to pollution havens which have low regulation in order to attract foreign capital or instead to excessively stringent “not-in-my backyard” (NIMBY) policies (see for instance Markusen et al., 1995; Rauscher, 1995; Elliott and Zhou, 2013; Erdogan (2013) provides a survey of the literature.).

For instance, Markusen et al. (1993) analyze the location choices of two Cournot oligopolists that are associated with different countries. These firms choose between having only their home-country plant, opening an additional plant in the foreign country and closing down production altogether. Contrary to our paper, complete relocation to the other country is not an option. The paper focuses exclusively on how environmental taxes affect location choices of the two firms. Regulation is treated as exogenous. Thus, there is no discussion of the central issue in our paper, namely how the anticipated location decisions of firms affect regulation itself. Motta and Thisse (1994) pursue the same questions in a similar model, except that, in their paper, firms are already established in their home country. The paper only reports “some tentative results” on the relation between environmental taxes and welfare for specific parameter values, identifying, in particular, the possibility of discontinuous jumps in welfare at tax levels inducing relocation.<sup>10</sup> Most closely related to our paper, Markusen et al. (1995) analyze a tax competition game between two jurisdictions facing a monopolist with increasing returns who generates local pollution. However, the jurisdictions care only about consumer surplus; firm lobbying is not an issue. The authors show that the equilibrium tax levels may be inefficient, resulting in too few or too many plants. The paper does not deal with the central issue of this paper, namely how susceptibility to lobbying affects the behavior of jurisdictions, and how the influence differs between national and multinational firms.

Lobbying in the context of firm location has been analyzed less frequently. Some contributions address lobbying of regions that compete for or against the settlement of firms which produce a local public good or bad. For instance, Belletini and Kempf (2008) analyze the spatial allocation of produc-

---

<sup>10</sup>Motta and Thisse define welfare as the sum of home country consumer surplus and profits minus home country damages plus some fraction of foreign country profits of the home country firm.

tion plants when regions lobby a central government to influence the local presence of a firm. Lobbying may lead to over- or underprovision of the public good which the firms provide. Closely related, Fredriksson (2000) analyzes the allocation of a plant which exerts negative externalities in a NIMBY setting where each region lobbies against the location of the plant at its own site, but benefits from its existence somewhere else. Thus, both papers also deal with how lobbying influences location patterns. However, our model focuses on lobbying of firms, rather than lobbying of regions. Like the present paper, Cole et al. (2006) analyze lobbying activities of multinational and national firms against environmental regulation when local production causes pollution damages. The authors show how an increase in the number of foreign plants affects environmental regulation in the presence of lobbying. In contrast to our approach, the market structure is exogenous and relocation is not allowed.

To sum up, the existing papers on lobbying in the context of FDI and firm location do not address how the influence activities of firms affect environmental regulation. The existing papers on the relation between regulation and location choice mostly treat regulation as an exogenous parameter. Where it is endogenized, the role of lobbying and the differences between national and multinational firms are not addressed.

### 3 Assumptions

We consider a multi-stage game of environmental regulation in a small country: Its environmental regulation does not induce reactions of policy in the rest of the world, which has a low level of regulation that we normalize to zero.

#### 3.1 *Product market*

There are two countries,  $i = 1$  (home) and  $i = 2$  (foreign). There is one firm that initially only has one plant in the home country. This firm can be national or multinational. A multinational firm is defined by the option to build another plant in the foreign country.<sup>11</sup> Even for the multinational firm, we will assume that at least a positive fraction of its owners live in the country under consideration.

---

<sup>11</sup>Our main insights still hold if both firms can relocate in principle, but a “multinational” firm can do so at lower costs than a “national” firm, reflecting a home bias of the latter.



We assume that a politician in country 1 maximizes a “welfare function” ( $W$ ), a weighted sum of consumer surplus in the home country ( $K$ ), total firm profits ( $\Pi$ ), net of the costs of environmental damage in the home country ( $D$ ):

$$W = K + \gamma\Pi - D, \quad (1)$$

where  $\gamma \geq 0$ . The game has the following stages:

1. The politician chooses the regulation level  $r$  so as to maximize  $W$ .
2. If the firm is multinational, it decides whether to build an additional plant in the foreign location at fixed cost  $F$ ; a national firm is defined by the absence of this option.<sup>12</sup>
3. The profit-maximizing firm chooses  $x_j^i$ ,  $i, j = 1, 2$ , which denotes the output levels produced in country  $i$  for country  $j$ .

We write  $x^i = (x_1^i + x_2^i)$  for total output produced in country  $i$ , and  $x_j = (x_j^1 + x_j^2)$  for total output produced for consumption in country  $j$ . Further, we write  $\mathbf{x} = (x_1^1, x_2^1, x_1^2, x_2^2)$ . *Partial relocation* (P) occurs if  $x^1 > 0$  and  $x^2 > 0$ , that is, production takes place in both countries. There is *complete relocation* (C) if  $x^1 = 0$ ,  $x^2 > 0$ , that is, all production takes place in country 2. If  $x^2 = 0$ , we say that there is *no relocation* (N).

We assume that the firm is a monopolist on both markets who faces linear demand  $p_i = \max\{a - x_i, 0\}$  in country  $i = 1, 2$ . We assume constant marginal production costs, which we set to 0 for simplicity. If a market is served from another country, the firm incurs transportation (or trade) costs  $t > 0$  per unit output. Regulation is assumed to increase the marginal costs of production from zero to  $r > 0$  units per unit of output. Profits of a regulated multinational are thus

$$\sum_{j=1}^2 p_j(x_j)x_j - rx^1 - t(x_2^1 + x_1^2) - \delta F \quad (2)$$

where  $\delta = 1$  if there is complete or partial relocation,  $\delta = 0$  otherwise, that is, for a national firm or a multinational firm that does not relocate. Environmental damages are given as  $b(x^1)^2$ , where  $b > 0$ . In the foreign country, there is no regulation. Again, we can think of this as a convenient normalization, except that we are restricting the country under consideration to introduce regulation that goes beyond the level in other countries.<sup>13</sup> The

<sup>12</sup>Fixed costs in the home country are sunk and cannot be recouped by shutting down a plant location. They are independent of the type of relocation (partial or complete). Allowing for differences in the fixed costs of partial and complete relocation does not change the main insights of the analysis and complicates notation.

<sup>13</sup>In Appendix E, we relax this assumption as well.

model thus has the exogenous parameters  $a, F, b, t, \gamma$ . The regulation level  $r$  is endogenous, as is the location choice and more generally the output vector  $x$ .

### 3.2 Lobbying interpretation

In principle, the parameter  $\gamma$  could reflect the weight that the benevolent politician gives to producer surplus.<sup>14</sup> Our preferred interpretation, however, is that it reflects the political clout of the firm. For instance, the regulator could be maximizing a political support function (see Peltzman, 1977) or she could be engaged in a lobbying game with the firm (see Grossman and Helpman, 1994). To see the latter point, it is well-known that maximization of (1) can be interpreted as a reduced-form description of behavior in a lobbying game. In a first stage of this game the firm offers a contribution schedule  $C(r)$  to the politician, which maps a particular level of regulation to a contribution that the firm pays to the politician. The firm's objective function thus becomes  $\pi(r) = \Pi(r) - C(r)$ , that is, profits minus contributions. Next the politician sets regulation levels so as to maximize  $U(r) = \widehat{W}(r) + \beta C(r)$ , where  $\beta \geq 0$  and  $\widehat{W}(r) = K + \widehat{\gamma}\Pi - D$  is the "true" welfare function where the weight parameter  $\widehat{\gamma}$  reflects normative considerations.

It is straightforward to show that the regulation level resulting from this more complex game maximizes a weighted sum of welfare and profits. The weight  $\gamma$  of profits is the sum of the true weight  $\widehat{\gamma}$  and the politicians concern for private benefits,  $\beta$ . Thus, our simpler game can be regarded as a reduced form of the more complex lobbying game.

## 4 Firm behavior

We first describe the behavior of a multinational firm for given regulation. Intuitively, a multinational firm faces simple trade-offs when it takes location decisions. If it does not relocate, it saves fixed costs relative to the alternatives of complete or partial relocation. Compared to complete relocation, it incurs the costs of regulation. Compared to partial relocation, it incurs transportation and regulation costs. If it relocates partially rather than completely, it saves transportation costs, but incurs regulation costs.

---

<sup>14</sup>Typically  $\gamma \leq 1$  would be assumed, reflecting either distributional preferences for consumers or foreign ownership of assets. Note that  $\gamma$  is independent of the location choice, which reflects the idea that the politician identifies the firm as one with national ownership independent of its production structure.

The following assumptions guarantee that (i) it is possible to earn positive profits in a country that is served from abroad and (ii) the profits that can be obtained in the unregulated foreign country from serving this country locally outweigh the fixed costs.<sup>15</sup>

**Assumption 1** (i)  $t < a$ , (ii)  $a^2 > 4F$ .

In Appendix A.1, we show that, for optimal output choices, profits in the different locational regimes are:

$$\begin{aligned}\Pi^N(r) &= \begin{cases} \frac{1}{4} [2a^2 - 2a(t + 2r) + (t + r)^2 + r^2] & \text{if } r \leq a - t \\ \frac{1}{4} [a^2 - 2ar + r^2] & \text{if } a - t < r \leq a \\ 0 & \text{if } a < r \end{cases} \\ \Pi^P(r) &= \frac{1}{4} [2a^2 - 2ar + r^2 - 4F] \quad \text{if } r \leq a \\ \Pi^C(r) &= \frac{1}{4} [2a^2 - 2at + t^2 - 4F] \end{aligned} \quad (3)$$

$\Pi^N(r)$ , the profit of a multinational firm that does not relocate even though it is allowed to do so in principle, is the same as the profit of a national firm that cannot relocate. In the case  $r \leq a - t$ , both markets are served: The joint costs of transportation and regulation are not too high to prevent exports. If  $a - t < r \leq a$ , no profits can be earned from serving the foreign country because the combined costs of transportation and regulation are too high, whereas regulation is not too costly to stop production altogether. For  $a < r$  regulation alone suffices to choke production even for the home-country market.

The multinational will choose the location  $l(r) \in \{C, N, P\}$  that maximizes  $\Pi^l(r)$ . Straightforward calculations (see Appendix A.2) show that there are critical levels of regulation,  $r_1 = r_1(a, t, F)$  and  $r_2 = r_2(a, t, F)$  and  $r_3 = t$  such that location choice is given as

$$l(r) = \begin{cases} N & \text{if } r \leq \min\{r_1, r_2\} \\ P & \text{if } r_1 < r < r_3 \\ C & \text{if } r \geq \max\{r_3, r_2\} \end{cases} \quad (4)$$

Thus, if regulation increases beyond certain levels, relocation takes place. Figure 1 gives the location choices for specific parameterizations.<sup>16</sup>

<sup>15</sup>To see this, note that (i)  $t < a$  guarantees that the maximal willingness-to-pay is above the transportation costs; (ii)  $a^2/4$  is the profit in the unregulated foreign country (with zero marginal cost).

<sup>16</sup>As illustrated in this figure, it is possible that  $r_1 = r_3$ , so that the partial relocation regime disappears, or that  $r_1 = 0$ , so that partial relocation arises even when there is no regulation.

— Figure 1 (about here): Location decisions of the multinational. —

Increases in demand  $a$  and reductions in fixed costs  $F$  reduce the size of the no-relocation region.<sup>17</sup>

For later purposes, we show that the relation between transportation costs and location patterns identified in Figure 1 holds more generally.

**Lemma 1:** *There exist values  $t^1 = t^1(a, F)$ ,  $t^2 = t^2(a, F)$  such that*

*(i) For  $t \leq t^1$ , the firm chooses no relocation for low values of regulation and complete relocation for high levels. Partial relocation never arises. (NC)*

*(ii) For  $t \geq t^2$ , the firm chooses partial relocation even for zero regulation and complete relocation for high levels of regulation (PC).*

*(iii) For  $t^1 \leq t \leq t^2$ , the firm chooses no relocation for low values of  $r$ , partial relocation for intermediate values and complete relocation for high values. (NPC)*

The proof is straightforward (see Appendix A.3).<sup>18</sup> The intuition is simple: (i) When transportation costs  $t$  are low, it is never worthwhile to build a plant in the other country to serve only this country. However, it can be worthwhile to avoid high regulation costs by relocating completely. (ii) When transportation costs  $t$  are very high, the firm will always serve the other country locally even when there is no regulation. (iii) For intermediate cases all locational patterns emerge for suitable  $r$ .

## 5 Determining regulation

We first consider the optimal regulation for a national firm; then we move to the multinational firm. In Appendix B we derive the expressions for home-country welfare when the firm serves both markets ( $r \leq a - t$ ) and when it produces only for the national market ( $a - t < r \leq a$ )<sup>19</sup>. We use these expressions to characterize how the optimal regulation depends on the magnitude of the environmental damage,  $b$ , and on the firm weight,  $\gamma$ . Let  $\gamma^1 \equiv b - \frac{1}{2}$ ;  $\gamma^2 \equiv 2b - \frac{1}{2}$  and  $\gamma^3 \equiv 2b - \frac{a}{2(a-t)}$ . Clearly,  $\gamma^1 \leq \gamma^2 \leq \gamma^3$ .

**Proposition 1** *(i) If  $\gamma \leq \gamma^1$ , regulation is so high ( $r = a$ ) that there is no production of the national firm.*

<sup>17</sup>This result can be derived by straightforward calculation based on the functions describing the boundaries between the three regions.

<sup>18</sup> $t^1$  corresponds to the intersection of the boundaries of all three regimes  $N$ ,  $P$  and  $C$ , and  $t^2$  corresponds to the value where the “ $\Pi^N = \Pi^P$ ”-line intersects with the  $x$ -axis.

<sup>19</sup>This also contains the case where the firm closes down production completely ( $r = a$ ). We do not discuss the possibility that  $r > a$  explicitly, because it is equivalent to  $r = a$ . That the firm produces only for the home market if  $a - t < r$  can be seen directly from the values for the optimal output for  $N$  (equations (7) in Appendix A.1).

- (ii) If  $\gamma^1 < \gamma \leq \gamma^2$ , regulation is just high enough that the national firm only produces for the home country ( $r = a - t$ ).
- (iii) If  $\gamma > \gamma^2$ , the national firm produces for both countries. If  $\gamma < \gamma^3$ ,  $r$  lies strictly between 0 and  $a - t$ , and it is decreasing in  $\gamma$  and  $t$ , increasing in  $a$  and  $b$ . If  $\gamma \geq \gamma^3$ ,  $r = 0$ .

**Proof:** See Appendix C.

The result is intuitive: If the environmental problem is important and firms do not have much weight ( $\gamma < \gamma^1$ ), then production will be shut down completely. As the influence of firms increases ( $\gamma > \gamma^1$ ), regulation will be softened to allow production for the home country. Eventually ( $\gamma > \gamma^2$ ), regulation becomes so soft that the firm will produce for both countries, and there will be no regulation if the weight of the firm is sufficiently strong.<sup>20</sup> The critical values  $\gamma^1, \gamma^2, \gamma^3$  are increasing in  $b$ , because regulation levels depend on the trade-off between damages and concern for producer rents. For very low  $b$ , there is no regulation ( $\gamma^3$  is negative). As the environmental problem becomes more severe ( $b$  increases), regulation increases gradually until the firm no longer exports to the foreign country. Finally  $r$  becomes so high that production is shut down altogether.

Appendix C contains a formula for the optimal level of  $r$  when there is an interior solution in the regime where both markets are served. We will use this solution when we compare the national and multinational firm in Section 6.

We now characterize the optimal regulation of the multinational firm and the corresponding location decisions.

**Proposition 2** *For the multinational firm, there exist critical levels of firm influence  $\gamma^{C1}, \gamma^{C2}, \gamma^{C3}, \gamma^{P2}$  such that.<sup>21</sup>*

- (i) *For  $t \leq t^1$ , complete relocation arises if and only if  $\gamma \leq \gamma^{C1}$ , with regulation levels*

$$r^C = a - \frac{t}{2} - \frac{1}{2}\sqrt{-8F - 4at + 4a^2 + t^2};$$

*there is no relocation for  $\gamma > \gamma^{C1}$ , and the regulation level is  $r^N = 0$ .*

- (ii) *For  $t^1 \leq t \leq t^2$ , there is complete relocation if and only if  $\gamma \leq \gamma^{C2}$ ; the*

---

<sup>20</sup>The result that there never is a solution in the interior of the regime with only home country production should not be overemphasized: It comes from the fact that, in this case, because of the specific functional forms we are employing, environmental damages and consumer surplus are proportional to the square of local output.

<sup>21</sup>These quantities are defined in Appendix E.

regulation level is  $r^C = t$ . There is partial relocation if and only if  $\gamma^{C2} < \gamma \leq \gamma^{P2}$ , with regulation level

$$r^P = a - t - \sqrt{a^2 - 4F}.$$

There is no relocation if and only if  $\gamma > \gamma^{P2}$ ; in this case, regulation is  $r^N = 0$ .

(iii) For  $t > t^2$ , there is complete relocation and regulation  $r^C = t$  if and only if  $\gamma \leq \gamma^{C3}$ . There is partial relocation and  $r^P = 0$  if and only if  $\gamma^{C3} < \gamma$ .

**Proof:** See Appendix D.

In essence, Proposition 2 states that relocation is fostered by low firm influence and low transportation costs. To prove this result, one has to take the effects of regulation on location decisions into account. Appendix B gives the welfare levels for each regime as  $W^N(r)$ ,  $W^P(r)$  and  $W^C(r)$ , respectively.  $W^N(r)$ , the welfare in regime  $N$ , is the same as for the national firm.

The regulation levels for arbitrary parameterizations of Proposition 2 will be useful when we compare the regulation of the national and multinational firm in the next section. The calculations show that a higher damage parameter  $b$  works in favor of relocation, whereas increasing  $\gamma$  works against it. Furthermore, Proposition 2 shows that partial relocation only arises for sufficiently high transportation costs ( $t > t^1$ ).

## 6 National vs. multinational firms

We now ask under which circumstances regulation leads a multinational firm to produce and pollute less than a national firm. As a first benchmark case, we consider  $\gamma = 0$ . There are several reasons for choosing this benchmark. First, it appears to be a natural starting point for an analysis of regulatory capture by industry. Though even a regulator who is not captured by industry might want to put some weight on industry profits, in the extreme case where  $\gamma = 0$  regulatory decisions definitely do not result from regulatory capture by firms. Second, there are cases where public agencies are supposed to use consumer standards (Neven and Röller 2005). Third, previous related literature usually sets  $\gamma = 0$ .<sup>22</sup> Thus, this benchmark is useful to position our results relative to this literature.

Nevertheless, we also consider another particularly interesting benchmark case, namely  $\gamma = 1$ . In this case, total surplus is maximized. This could, in

<sup>22</sup>This is, in particular, true for Markusen et al. (1995) and Rauscher (1995).

principle, also arise when a regulator is not captured by lobbyists, but simply puts equal weight on firms and consumers. We therefore also consider a case where  $\gamma > 1$  (namely  $\gamma = 1.5$ ) where it is particularly plausible that such a weight reflects lobbying by the firm.

It will turn out that, for some values of  $b$  and  $t$ , the multinational firm produces and pollutes less than the national firm for low  $\gamma$ , but more for high  $\gamma$ ; whereas for other values of  $b$  and  $t$ , the multinational firm produces and pollutes more than the national firm for low  $\gamma$ , but less for high  $\gamma$ . However, there is one robust observation: The region where output and pollution are higher for multinational firms than for national firms involves more damaging pollutants.

### 6.1 Pure consumer surplus maximization

Suppose as a benchmark that  $\gamma = 0$ . We fix  $a$  and  $F$ , leaving us with the free parameters  $t$ ,  $b$ . The left panel of Figure 2 captures the relocation patterns for the multinational (N,P or C), and it shows for which combinations of  $t$  and  $b$  the multinational has higher domestic output than the national firm (white regions), lower domestic output (black) or the same output (grey).

— Figure 2 (about here): Locations and output ( $a = 4$ ,  $F = 3$ ): Left:  $\gamma = 0$ ; Middle:  $\gamma = 1$ ; Right:  $\gamma = 1.5$ . MNE>Nat: white; MNE=Nat: grey; MNE<Nat: black. —

Relocation regimes in the  $(t, b)$ -diagram are similar to those in the  $(t, r)$ -diagram because more damaging pollutants (high  $b$ ) induce more regulation (high  $r$ ). As to the comparison between the multinational and the national firm, the figure leads to the following observation:<sup>23</sup>

**Result 1** *The following statements hold for the benchmark case  $\gamma = 0$ :*

- a) The multinational produces less than the national firm (i) for low  $t$  and intermediate values of  $b$  and (ii) for high  $t$  and low  $b$ .*
- b) The multinational produces more than the national firm for high values of  $t$  and intermediate values of  $b$ .*

In the remainder of this subsection, we provide the intuition for these observations. The results hold in general, and Figure 2 illustrates them for a specific parameterization. The left hand side of Figure 2 represents the case without lobbying; the right hand side shows how lobbying affects location structure and output.

---

<sup>23</sup>Of course, when the environmental problem becomes sufficiently severe, both firms face regulation that chokes off pollution.

To understand the intuition for a)(i), first consider the part of the complete relocation regime  $C$  where the national firm is active (low  $t$ , intermediate  $b$ ). There the multinational firm trivially has lower domestic output than the national firm, as it does not produce in the home country. For low transportation costs  $t$ , the reduction in consumer surplus from relocation is low, because the multinational will serve the home country from abroad without substantial price increases. Thus, the regulator is prepared to induce complete relocation of the multinational firm to improve environmental quality. With a national firm, the environmental benefits from shutting down would come at the costs of losing consumer surplus altogether, so that the regulator is more reluctant to close down the national firm.

As to a(ii), for high  $t$ , there is partial relocation of the multinational. The left panel of Figure 2 shows that, in regime  $P$ , there is a critical level of  $b$ , below which the multinational produces a lower domestic output than the national firm. To understand the intuition, we focus on the case  $t > t^2$ , so that there is partial relocation even for  $b = 0$ .<sup>24</sup> The multinational chooses partial relocation because transportation costs are high: Even for  $b = 0$ , when there is no regulation, it serves the foreign country from abroad. As the national firm lacks this option, it also produces its exports at home. As a result, the national firm produces and pollutes more than the multinational firm.

b) As in a(ii), we continue to suppose that transportation costs are high. As the damage parameter increases, regulators first start regulating the national firm, because the benefits from regulating a firm with a larger home-country output are larger. As  $b$  increases within regime  $P$ , the regulation of the national firm eventually becomes so strict that it produces less output than the multinational firm which is still not regulated. The intuition is as follows: As environmental damages are large enough, the government wants the firm to close down export production to reduce pollution. Whereas the multinational firm does this even for  $r = 0$  (because it has the alternative of production abroad), the national firm only abolishes export production for sufficiently strict regulation,  $r \geq a - t$ . This leads to lower output of the national firm compared to the multinational that faces less regulation.

## 6.2 Increasing influence of the firm

We now assess the effects of a positive weight of the firm's profit in the welfare function ( $\gamma = 1$ ), reflecting greater importance of private benefits in the regulator's objective function. Clearly, regulation is reduced as  $\gamma$  increases,

---

<sup>24</sup>For  $t^{1*} < t < t^2$ , the argument is similar.



no matter whether the firm is national or multinational. The more interesting question is whether it becomes more or less likely that the multinational faces less regulation than the national firm, and what the welfare effects are.

The middle panel in Figure 2 considers the case where consumer and producer surplus get the same weight ( $\gamma = 1$ ); the panel on the right reflects a situation where producer surplus gets higher weight ( $\gamma = 1.5$ ). As  $\gamma$  increases, the parameter region where the multinational firm produces and pollutes more moves upwards. More precisely, we obtain the following observation.

**Result 2** *As firm weight increases, (i) for low transportation costs, the area where the multinational firm produces lower output and pollution than the national firm is characterized by higher values of  $b$ ; (ii) for high transportation costs, the area where the multinational firm produces higher output and pollution than the national firm is characterized by higher  $b$ .*

We now provide the intuition for the result. Comparison of the panels in Figure 2 shows that an increase in  $\gamma$  has the following effects:

(i) The complete relocation regime shifts upwards, because multinational lobbying prevents restrictive regulation. However, as the national firm also has stronger weight than before, the region where they have to close down is also pushed upwards. As a result, for low  $t$ , both the lower and the upper bound of the region where the multinational firm produces strictly less output than the national firm moves up.

(ii) The second effect arises only in the partial relocation regime  $P$ , that is, for high  $t$ . The intuition is similar as in case (i). As the firms' weight grows, it face less regulation, no matter whether it is national or multinational. This leads to an upward shift in the regime boundaries. First, as in the case  $\gamma = 0$ , for higher values of  $\gamma$  there is a critical level of  $b$  above which the multinational firm produces higher domestic output than the national firm. However, this requires that the national firm is regulated so heavily that exports are curbed, which will only happen for higher values of the damage parameters than for the case without lobbying ( $\gamma = 0$ ). Similarly, the upper boundary of the region where the multinational produces more than the national firm is determined by the point where the multinational completely relocates. Again, this point moves upwards as the multinational's influence increases.

As a final observation, note the following non-monotonicity in the effects of increasing firm influence  $\gamma$ : For some values of  $b$  and  $t$  (e.g.  $t = 3$ ,  $b = 0.8$ ), increasing  $\gamma$  from 0 to 1 leads to from a situation where pollution of the national and multinational firm is the same to a situation where the multinational pollutes more. Increasing  $\gamma$  from 1 to 1.5 then leads to a situation where multinational firms pollute less.

## 7 Welfare

The results in the previous section strongly suggest that the presence of multinational firms has ambiguous effects on welfare. On the one hand, where the multinational is induced to relocate, local pollution will decline. On the other hand, relocation may lead to reductions in consumer surplus.

However, by choosing regulation accordingly, the government can avoid relocation if desired. At first glance, it might therefore seem that a country is always better off with a multinational firm, because this adds the option of inducing exit of an undesired firm without losing consumer surplus completely. However, with a multinational firm the government loses the option to regulate the firm heavily and nevertheless have local production – the firm will vote with the feet when regulation gets too stringent.

— Figure 3 (about here): Welfare ( $a = 4$ ,  $F = 3$ ): Left:  $\gamma = 0$ ; Middle:  $\gamma = 1$ ; Right:  $\gamma = 1.5$ . MNE>Nat: white; MNE=Nat: grey; MNE<Nat: black. —

In spite of these potential ambiguities, our model yields a very clear result: For  $\gamma = 0$ , a country is always better off when the monopolist is multinational rather than national, except for a small region where regulation and welfare are identical for both types of firms. The left hand side of Figure 3 represents the welfare comparison absent lobbying. Welfare is the same with a national or multinational firm if the multinational prefers to stay at home (grey area). For all other parameter regions, welfare is higher if the firm is a multinational. The intuition can be obtained from this figure, which is closely related to Figure 2. First, consider regime *C*: When the environmental damage is so substantial that the production of the national firm is choked off entirely whereas the multinational produces abroad, welfare is clearly higher with the multinational. This reflects the fact that the multinational still generates consumer surplus for the home country (without causing pollution at home). As the environmental damage parameter declines, the national firm is regulated less, so that it at least produces for the local market: Contrary to the multinational firm, the national firm therefore generates environmental damage, but because transportation costs are fairly small, so are the losses in consumer surplus from having a multinational rather than a local firm. In regime *P*, first consider low damage parameters. Then, contrary to the multinational firm, the national firm produces for both countries. The additional output for the foreign country creates more pollution than in the case of the multinational without generating more consumer surplus. As the pollution parameter increases, so that the government wants to curb exports of the national firm, strict regulation is necessary to induce this, so that the

multinational firm generates higher consumer surplus without substantially more pollution.<sup>25</sup>

The situation changes when lobbying is taken into account. The two remaining panels in Figure 3, which correspond to the middle and right panel in Figure 2, compare welfare (defined as pure consumer surplus minus damages) for the national and the multinational firm when firms have a positive weight ( $\gamma = 1$  and  $\gamma = 1.5$ ). The figure shows that in both of these cases there is a region where welfare with a multinational firm is lower than with a national firm (shaded dark). In this region, there is partial relocation, and the multinational firm produces more than the national firm. As discussed in Section 6, the multinational firm is regulated less than the national firm because strict regulation of the national firm is necessary to prevent export production from the home country, whereas partial relocation of the multinational does not necessarily require very strict regulation.<sup>26</sup> This increases environmental damages and reduces welfare compared to the national firm. Note the qualitative difference between increasing  $\gamma$  from 0 to 1 and from 1 to 1.5: The first increase introduces an area where welfare is lower with multinational firms; the second increase moves it upwards, that is, requires a higher environmental damage parameter for its emergence.

We sum up the observations from Figure 3 as follows.

**Result 3** *For  $\gamma = 0$ , welfare is always higher with a multinational firm than with a national firm. As  $\gamma$  increases, parameter regions emerge where welfare is lower with the multinational.*

This result illustrates the effects of lobbying on welfare: Even though our setting is biased in the sense that a consumer-surplus maximizing government is always better off with a multinational, this changes with lobbying: There are parameter regions (with fairly high environmental damage parameter) where the increasing influence activities reverse the welfare comparison.

## 8 Discussion and generalizations

In a simple monopoly model, we investigated whether national or multinational firms pollute more heavily in the home country. We also dealt with the

---

<sup>25</sup>We want to point out the clear result for  $\gamma = 0$  is due to the model specification where both the consumer surplus and the damage function are quadratic in output. For other functional forms, the area where welfare with the multinational is lower than with the national firm may already emerge for  $\gamma = 0$ .

<sup>26</sup>Recall that, to economize on transportation cost, a multinational firm may even choose partial relocation without any regulation.

relation between lobbying, firm type and welfare. One might be concerned about the robustness of the conclusions. In Appendix E, we introduce a model with more general assumptions on the demand structure, the nature of regulation and the damage function that are compatible with our specific example. We briefly discuss this model in Section 8.1. In Section 8.2, we then consider various conceivable modifications of the model, and we discuss to which extent they can be addressed in the more general setting.

### 8.1 *The general model*

In Appendix E, we show that most of the major conclusions apply in a more general setting. Rather than specifying a particular parametric model, we formulate assumptions on the relation between the regulatory instrument and product market outcomes that are satisfied in various contexts including the model previously introduced. For instance, we assume that outputs and profits in a country are positive without regulation. Moreover, they decrease as regulation becomes more stringent, until they finally become zero as a prohibitive level of regulation is reached.

In this setting, we show that the location choices of the firm have the same qualitative properties as in Section 4: First, there never is complete relocation when there is no regulation in the home country.<sup>27</sup> Second, if regulation and transportation costs are small, no relocation occurs. Third, if foreign country regulation is not too strict to prevent positive profits (net of relocation costs) from serving the home country from abroad, complete relocation occurs for sufficiently strict regulation in the home country. Fourth, whether relocation is partial or complete depends on the interaction between regulation and transportation costs: For low transportation costs, partial relocation is never optimal, while for higher transportation costs partial relocation can be optimal and no relocation is never chosen.

We then go on to show that the comparison between national and multinational firms identified in Section 6.1 is still valid in this more general setting. To this end, we assume that the regulator maximizes a weighted sum of consumer surplus (minus damages) and profits, where consumer surplus depends positively on output sold in the home country and damages depend positively on outputs produced in the home country. Moreover, we assume that the optimal regulation is continuous in parameters, and that it involves zero home-country output as the damage parameter becomes high enough.

In this setting, the main results are as follows. As in the specific model treated above, for low transportation costs, governments choose regulation so

---

<sup>27</sup>Note that in this case partial relocation may occur due to high transportation costs.

that the multinational exercises the option of relocation when environmental damages are high (and hence regulation becomes stricter); the national firm then produces and pollutes at least as much as the multinational. As transportation costs increase, there is another region where the national firm pollutes more, but the reasons are different: The multinational firm chooses partial relocation and is therefore less active. What we cannot show in the general model is that there necessarily is a region where the multinational firm pollutes more in the home country than the national firm. However, it is also not evident why this result should be an artefact of the specific model of Section 4.

## 8.2 *Discussion of specific assumptions*

### 8.2.1 *Objective function of the regulator*

In the objective function of the regulator (1), the weight on profits is the same for national and multinational firms, and it is independent of whether the monopolist produces entirely at home or in the foreign country. This is clearly a simplification: One could imagine that a regulator puts a higher weight on national firms than on multinational firms and that she cares more about the profits of a multinational firm earned in the home country than about those earned in the foreign country. This point is also relevant with our preferred interpretation of the weight as reflecting lobbying incentives (rather than the weight that a benevolent regulator would put on profits): A home country firm might have easier access to the regulator than a firm located abroad, which could make it a more effective lobbyist. However, recall that, at the time that lobbying takes place, the firm is present in the home country, no matter whether it is a national or a multinational firm and whether it will subsequently relocate or not. We thus believe that, in this context, the assumption of symmetric profit weights is fairly innocuous.

If one were to nevertheless put a higher weight on home-country profits of the multinational firm than on the profits they earn abroad, this would clearly increase the incentives to keep the firm at home (which in the current version of the model come exclusively from the desire to increase consumer surplus by saving on transportation costs). Thus, we conjecture that the parameter region with partial or complete relocation of the monopolist would become smaller.

### 8.2.2 *Technology*

We assume a very simple linear relation between output and pollution. The more general model in the appendix does not rely on linearity. As discussed

above, apart from symmetry assumptions, we merely use several innocuous assumptions: For instance, outputs and profits are positive without regulation, but react negatively to regulation in a given country, until a prohibitive level is reached. These assumptions suffice to generate the qualitative insights on firm behavior. Adding similarly standard assumptions on welfare then leads to a generalization of Proposition 2.

A more challenging issue is the realistic possibility of multi-dimensional choices of the firm. In our model, there is no way to react to home-country regulation in any other way than by output contraction (including the possibility of relocation). A more general option would be to allow the firm to change outputs as well as emissions per unit of output. This modification is beyond the scope of the paper, but, to the best of our knowledge, has not been treated elsewhere in the literature on location choice either.

### *8.2.3 Other policy instruments*

So far, we assumed that regulation imposes a cost on the firm without generating revenues for the state. Most related papers assume taxes.<sup>28</sup> Environmental taxes have received a lot of attention for their efficiency properties (as reflected in particular in the “double dividend” discussion). Nevertheless, command-and-control regulation is still very common, in particular, in the context of local pollution. It thus seems natural to consider such regulation in a positive analysis of regulatory behavior.

Having said that, it is still interesting to consider how the analysis would change with taxes. Intuitively, for a regulator who does not care about firm profits, taxes have the desirable feature that they redistribute income away from firms. Compared with a marginal cost-increasing regulation with the same induced cost per unit, it is more attractive to increase a tax because of the revenue received. However, the concern for revenues also implies that a regulator will be more reluctant to induce exit of the firm than in the case with a pure marginal cost-increasing regulation. This should exert a downward pressure on regulation. The net effect of using taxes rather than regulations is thus not clear. However, the analysis of Markusen et al. (1995) in a somewhat different setting at least suggests that taxes set by regulators who maximize consumer surplus can be excessively high or excessively low.

When firm profits enter the regulator’s objective (for instance, because of lobbying), additional considerations are necessary. If lobbying is so strong that firm profits receive more weight than consumer surplus, taxation has

---

<sup>28</sup>See for example Motta and Thisse (1994); Markusen et al. (1995); Rauscher (1995). Markusen et al. (1993) briefly discuss other interpretations of their framework.

a negative net redistributive effect for the regulator, which will reduce incentives to increase taxes for any given location structure. By analogous arguments as above, however, such a regulator is not concerned about reduced tax income from relocation, and she will therefore do less to prevent relocation.

In brief, the exact comparison between taxes and corresponding standards is not obvious. However, qualitatively, the behavior should be similar: The generalized model in the appendix also applies to taxes. Using Propositions 3 and 4, one can therefore show that the effect of taxes on location corresponds to the patterns identified in Section 4, and the differences in the regulation of national and multinational firms are similar to the case of standards discussed in Sections 3-7.

#### 8.2.4 *Global pollutants*

Like much of the related literature, we focus on local pollutants.<sup>29</sup> Intuitively, with global pollutants, there are smaller incentives for regulation in general, as only a small part of the benefits is captured by the regulating country. Moreover, there is no incentive whatsoever to follow a NIMBY policy and induce relocation for environmental reasons.

Nevertheless, we conjecture that there would still be differences between national and multinational firms: With global pollution, there still is the “race-to-the bottom”-argument for lax regulation towards multinational firms. Thus, we conjecture that, no matter what the weight of the firm is, multinational firms would be regulated less than national firms with global pollution: As transportation costs are positive, consumer surplus is higher when the firm is in the home country. As the negative effect of pollution is independent of location, it is thus unambiguously beneficial for the regulator to avoid relocation.

## 9 Conclusions

In this paper, we compare regulatory policies of a small country that is influenced by the lobbying activities of a multinational firm. Regulation has an impact on location decisions of the monopolist. Consumer surplus net of environmental damages is always higher for a multinational firm than for a national firm when the regulator cares only about consumers. Thus, the regulator can avoid local pollution damages by driving the multinational out of the market and relying on imports whenever this is preferable from a

---

<sup>29</sup>Rauscher (1995) also considers global pollutants.

welfare perspective. The option of importing is not available with a national firm.

As lobbying influence increases, the region where the multinational produces and pollutes more now involves pollutants with higher damage parameters. Thus lobbying may have worse effects on welfare with a multinational firm than with a national firm. In particular, even though welfare is always higher with multinational than with national firms in the absence of lobbying, this is no longer the case with lobbying.

## Acknowledgements

We are grateful to Nick Netzer, Max Pfister, Lorenz Goette, Katrin Spitze and seminar participants at the University of Zürich and at meetings of the Verein für Socialpolitik (Annual Meeting Düsseldorf, Environmental Economics Group Darmstadt) for helpful comments.

## Appendices

### A The location decisions of the multinational

#### A.1 Deriving equation (3)

Using (2), profits in the different locations are

$$\Pi^N = p_1 x_1^1 + p_2 x_2^1 - r(x_1^1 + x_2^1) - t x_2^1 \quad (5)$$

$$\Pi^P = p_1 x_1^1 + p_2 x_2^2 - r x_1^1 - F \quad (6)$$

$$\Pi^C = p_1 x_1^2 + p_2 x_2^2 - t x_1^2 - F.$$

Simple calculations show that the optimal output levels are

$$\begin{aligned} x_1^1 &= \max\left(\frac{a-r}{2}, 0\right), x_2^1 = \max\left(\frac{a-r-t}{2}, 0\right) \text{ in regime } N \\ x_1^1 &= \frac{a-r}{2}, x_2^2 = \frac{a}{2} \text{ in regime } P \\ x_1^2 &= \frac{a-t}{2}, x_2^2 = \frac{a}{2} \text{ in regime } C. \end{aligned} \quad (7)$$

Inserting these choices into (5), we obtain (3).



## A.2 Locational choices

We now derive locational choices (4). Using (3), we first make pairwise comparisons of profits in the different regimes:

$$\begin{aligned}\Pi^N > \Pi^P &\Rightarrow \begin{cases} r^2 + t^2 + 2rt - 2ar - 2at + 4F > 0 & \text{if } r \leq a - t \\ -a^2 + 4F > 0 & \text{if } a - t < r \end{cases} \\ \Pi^P > \Pi^C &\Rightarrow \begin{cases} t > r & \text{if } r \leq a \\ \text{never} & \text{if } a < r \end{cases} \\ \Pi^N > \Pi^C &\Rightarrow \begin{cases} r^2 + rt - 2ar + 2F > 0 & \text{if } r \leq a - t \\ r^2 - t^2 - a^2 + 2at - 2ar + 4F > 0 & \text{if } a - t < r \leq a \\ 0 > 2a^2 - 2at + t^2 - 4F & \text{if } a < r \end{cases}\end{aligned}$$

For regime  $N$  to be chosen, we need  $\Pi^N > \Pi^P \wedge \Pi^N > \Pi^C$ . For  $r \leq a - t$  we therefore need :

$$r^2 + t^2 + 2rt - 2ar - 2at + 4F > 0 \wedge r^2 + rt - 2ar + 2F > 0.$$

For  $a - t < r \leq a$ ,  $N$  is optimal if

$$-a^2 + 4F > 0 \wedge r^2 - t^2 - a^2 + 2at - 2ar + 4F > 0.$$

For  $r > a$ , the condition becomes

$$-a^2 + 4F > 0 \wedge 0 > (a - t)^2 + a^2 - 4F.$$

Due to assumption 1(ii),  $a^2 > 4F$ , the second and the third case cannot occur. For the first case ( $r \leq a - t$ ), simple derivations show that the two conditions can be written as

$$r < \min \left\{ a - t - \sqrt{a^2 - 4F}, a - \frac{t}{2} - \frac{1}{2}\sqrt{(t - 2a)^2 - 8F} \right\}.$$

Defining

$$r_1 \equiv a - t - \sqrt{a^2 - 4F} \text{ and } r_2 \equiv a - \frac{t}{2} - \frac{1}{2}\sqrt{(t - 2a)^2 - 8F}, \quad (8)$$

the first statement in (4) follows.

For regime  $P$  to be chosen, we need  $\Pi^P > \Pi^N \wedge \Pi^P > \Pi^C$ . For  $r \leq a - t$ , we thus require

$$r^2 + t^2 + 2rt - 2ar - 2at + 4F < 0 \wedge t > r.$$

For  $r > a - t$ , the condition for  $P$  to be optimal is

$$-a^2 + 4F < 0 \wedge t > r.$$

Again, straightforward calculations show that location  $P$  is chosen in the following cases:

$$\begin{aligned} \text{for } r \leq a - t & : a - t - \sqrt{a^2 - 4F} < r < t \\ \text{for } r > a - t & : -a^2 + 4F < 0 \wedge r < t \end{aligned}$$

Using  $a^2 - 4F > 0$  and the fact that  $C$  is chosen in the remaining cases, where neither  $N$  nor  $P$  will be chosen, leads to the equations (4) for  $l(r)$ .

### A.3 Proof of Lemma 1

Define  $t^1 = \frac{a - \sqrt{a^2 - 4F}}{2}$  and  $t^2 = a - \sqrt{a^2 - 4F}$ . Using (4) and (8): regimes  $N$ ,  $P$  and  $C$  intersect at  $t^1$ , and  $t^2$  corresponds to the value where the “ $\Pi^N = \Pi^P$ ”-line intersects with the  $x$ -axis.

## B The expressions for welfare

Simple calculations show:

$$\begin{aligned} K^N &= \int_0^{x_1^1} (a - q) \mathbf{d}q - (a - x_1^1)x_1^1 = \frac{(x_1^1)^2}{2} \\ K^P &= \int_0^{x_1^1} (a - q) \mathbf{d}q - (a - x_1^1)x_1^1 = \frac{(x_1^1)^2}{2} \\ K^C &= \int_0^{x_1^2} (a - q) \mathbf{d}q - (a - x_1^2)x_1^2 = \frac{(x_1^2)^2}{2} \end{aligned} \tag{9}$$

$$\begin{aligned} D^N &= b(x_1^1 + x_2^1)^2 \\ D^P &= b(x_1^1)^2 \\ D^C &= 0 \end{aligned} \tag{10}$$

The welfare levels in the different locational regimes are then (taking  $\Pi$  from (5)):

$$\begin{aligned}
W^N &= \frac{(x_1^1)^2}{2} + \gamma[(a - x_1^1)x_1^1 + (a - x_2^1)x_2^1 - r(x_1^1 + x_2^1) - tx_2^1] \\
&\quad - b(x_1^1 + x_2^1)^2 \\
W^P &= \frac{(x_1^1)^2}{2} + \gamma[(a - x_1^1)x_1^1 + (a - x_2^2)x_2^2 - r(x_1^1) - F] - b(x_1^1)^2 \\
W^C &= \frac{(x_1^2)^2}{2} + \gamma[(a - x_1^2)x_1^2 + (a - x_2^2)x_2^2 - t(x_1^2) - F] \tag{11}
\end{aligned}$$

Inserting the values for the output from above (equation (7)) and discerning the cases as above gives <sup>30</sup>:

$$\begin{aligned}
W^N(r) &= \begin{cases} \text{if } r \leq a - t : & \frac{\gamma}{4} [2a^2 + 2r^2 + t^2 + 2rt - 4ar - 2at] \\
& + \frac{1}{8}(a - r)^2 - \frac{b}{4}(2a - 2r - t)^2 \\
\text{if } a - t < r \leq a : & \frac{\gamma}{4}(a - r)^2 + \frac{1}{8}(a - r)^2 - \frac{b}{4}(a - r)^2 \\
\text{if } a < r : & 0 \end{cases} \\
W^P(r) &= \begin{cases} \text{if } r \leq a : & \frac{\gamma}{4} [2a^2 + r^2 - 2ar - 4F] + \frac{1}{8}(a - r)^2 \\
& - \frac{b}{4}(a - r)^2 \end{cases} \\
W^C(r) &= \frac{\gamma}{4} [2a^2 + t^2 - 2at - 4F] + \frac{1}{8}(a - t)^2. \tag{12}
\end{aligned}$$

## C Regulation of national firms

### Proof of Proposition 1

(a) The welfare levels corresponding to  $r \geq a$  (No Production),  $r \leq a - t$  (Full Production) and  $a - t \leq r \leq a$  (No Exports) are given in equation (12). We first show that the optimal  $r$  and the corresponding welfare levels correspond to the values shown in Table 1.

(a1) Clearly, for  $r \geq a$ , welfare is 0, independent of  $r$ .

(a2) For  $r \leq a - t$ , firms produce both for both markets. Using the F.O.C for unconstrained maximization of  $W^N(r)$ ,

$$r = \frac{a(-4\gamma - 1 + 8b) + t(-4b + 2\gamma)}{-4\gamma - 1 + 8b}$$

is a candidate interior solution. However, this candidate is only in  $[0, a - t]$  if  $2b - \frac{1}{2} \leq \gamma < 2b - \frac{a}{2(2a-t)}$ . For  $\gamma < 2b - \frac{1}{2}$ ,  $W^N(r)$  is increasing in  $r$  on

---

<sup>30</sup>In regime P, we ignore the case  $r > a$ : In this case, the home market would not be served, so that complete relocation is always preferred.

$[0, a - t]$ , so that the optimum is  $r = a - t$ . For  $\gamma > 2b - \frac{a}{2(2a-t)}$ ,  $W^N(r)$  is decreasing in  $r$ , so the optimum is  $r = 0$ . Table 1 also contains the resulting welfare levels.

(a3) For  $a - t \leq r \leq a$ , it turns out that  $W^N(r)$  is always monotone, resulting in an optimum  $r = a$  if  $\gamma < b - \frac{1}{2}$  and  $r = a - t$  if  $\gamma > b - \frac{1}{2}$ .

(b) Next, we compare welfare in the candidate solutions. (b1) If  $\gamma < \gamma^1 \equiv b - \frac{1}{2}$ , the optimal solution is  $r = a - t$  in the full production regime and it is  $r = a$  in the no exports regime. Comparing the expressions for welfare, we obtain that  $r = a$  and  $W = 0$ . Hence, part (i) of the result follows.

(b2) If  $b - \frac{1}{2} < \gamma < \gamma^2 \equiv 2b - \frac{1}{2}$ , the candidate optimum in both regimes is  $r = a - t$ . Hence, part (ii) of the result follows.

(b3) If  $2b - \frac{1}{2} \leq \gamma < \gamma^3 \equiv 2b - \frac{a}{2(2a-t)}$ , the optimum in the full production regime is given by the interior solution. It has to be compared with the optimum in the No Exports regime ( $r = a - t$ ). Using the corresponding expressions in Table 1, it turns out that the full production optimum is superior.

(b4) If  $\gamma > \gamma^3$ , the optimum in the full production regime is  $r = 0$ , the optimum in the No Exports regime is  $r = a - t$ . Using the corresponding expressions for welfare in Table 1, it follows that full production is superior. Together with (b3), this implies Part (iii) of the result.

range of $\gamma$	$r =$	$W^N =$
$\gamma < b - \frac{1}{2}$	$a$	0
$b - \frac{1}{2} < \gamma < 2b - \frac{1}{2}$	$a - t$	$t^2(\frac{\gamma}{4} + \frac{1}{8} - \frac{b}{4})$
$2b - \frac{1}{2} \leq \gamma < 2b - \frac{a}{2(2a-t)}$	$\frac{a(-4\gamma-1+8b)+t(-4b+2\gamma)}{-4\gamma-1+8b}$	$\frac{t^4}{(1+2\omega)^2} [\frac{\gamma}{4}(2\omega^2 + 2\omega + 1) + \frac{\omega^2}{8} - \frac{b}{4}]$
$2b - \frac{a}{2(2a-t)} < \gamma$	0	$(2a^2 + t(t - 2a))\frac{\gamma}{4} + a^2\frac{1}{8} - \frac{b}{4}(t - 2a)^2$

Table 1: Optimal values for the regulation  $r$  and corresponding welfare levels for the national firm ( $\omega := -4b + 2\gamma$ )

## D Regulation of multinational firms

The proof of Proposition 2 requires several preliminary results.

**Lemma 2:** *Welfare under complete relocation is*

$$W^C = \left(\frac{\gamma}{4} + \frac{1}{8}\right) (a - t)^2 + \frac{\gamma}{4} (a^2 - 4F).$$

The corresponding minimal regulation is  $r^C = a - \frac{t}{2} - \frac{1}{2}\sqrt{-8F - 4at + 4a^2 + t^2}$  or  $r^C = t$ .

The result follows directly from (12). Intuitively, as the firm serves both countries from abroad, there is no home country pollution. The home country consumer surplus has to be calculated taking into account the transportation costs  $t$ , and similarly for total profits. As  $W^C$  is independent of regulation, any value of  $r$  inducing complete relocation can be chosen. A natural candidate is the lowest possible value that induces  $C$ , thus the lower boundary of the complete relocation region in the  $(t, r)$ -graph. These values for  $r$  can be taken from Appendix A.

**Lemma 3:** (i) If  $\gamma < b - \frac{1}{2}$  the constrained optimal choice of  $r$  in  $P$  lies on the upper boundary of  $P$  ( $r = t$ ). The resulting welfare level is

$$W^P = \left(\frac{\gamma}{4} + \frac{1}{8}\right) (a - t)^2 + \frac{\gamma}{4} (a^2 - 4F) - \frac{b}{4} (a - t)^2$$

(ii) If  $\gamma > b - \frac{1}{2}$  the constrained optimal choice of  $r$  in  $P$  lies on the lower boundary of  $P$ , which is  $r = a - t - \sqrt{a^2 - 4F}$  in NPC and  $r = 0$  in PC. The corresponding welfare levels are

$$W^{P-NPC} = \left(\frac{\gamma}{4} + \frac{1}{8} - \frac{b}{4}\right) \left(t + \sqrt{a^2 - 4F}\right)^2 + \frac{\gamma}{4} (a^2 - 4F) \quad (13)$$

$$W^{P-PC} = \left(\frac{\gamma}{4} + \frac{1}{8} - \frac{b}{4}\right) a^2 + \frac{\gamma}{4} (a^2 - 4F) \quad (14)$$

**Proof of Lemma 3:** The derivative of  $W^P(r)$  is  $\frac{1}{4}(r - a)(2\gamma - 2b + 1)$ . In regime P,  $r \leq a$ . Therefore,  $W^P$  is monotone increasing in  $r$  for  $\gamma < b - \frac{1}{2}$  and decreasing for  $\gamma > b - \frac{1}{2}$ . Thus in the former case the constrained optimum in P lies on the upper boundary of P, in the latter case it lies on the lower boundary (which is at  $a - t - \sqrt{a^2 - 4F}$  or at 0).

We use these results and Proposition 1 to prove Proposition 2.

**Proof of Proposition 2:**

We define the critical levels of  $\gamma$  as follows:

$$\begin{aligned}
\gamma^{C1} &\equiv \max \left\{ \frac{-a + 8ab - 4bt}{4a - 2t}, \frac{(t - 2a)(t + 2b(t - 2a))}{8F} \right\} \\
\gamma^{C2} &\equiv \max \left\{ \begin{aligned} &b - \frac{1}{2} \\ &\min \left( \frac{b(t + \sqrt{a^2 - 4F})^2}{t\sqrt{a^2 - 4F} - 2F + at} - \frac{1}{2}, 2b - \frac{a}{2(a-t)} \right) \\ &\min \left( \frac{b(t + \sqrt{a^2 - 4F})^2}{t\sqrt{a^2 - 4F} - 2F + at} - \frac{1}{2}, \frac{2b(2a-t)^2 - t(2a-t)}{8F} \right) \end{aligned} \right\} \\
\gamma^{P2} &\equiv \max \left\{ \begin{aligned} &2b - \frac{a}{2(a-t)}, \\ &\frac{2b(2t\sqrt{a^2 - 4F} + 4at - 3a^2 - 4F) - (t^2 + 2t\sqrt{a^2 - 4F} - 4F)}{2(2t\sqrt{a^2 - 4F} + 2at - 8F)} \end{aligned} \right\} \\
\gamma^{C3} &\equiv \frac{ba^2}{t(2a - t)} - \frac{1}{2}
\end{aligned}$$

(i) We show that for  $t < t^1$  complete relocation arises if and only if  $\gamma < \max \left\{ \frac{-a + 8ab - 4bt}{4a - 2t}, \frac{(t - 2a)(t + 2b(t - 2a))}{8F} \right\}$ . We distinguish four cases:

(a) Let  $\gamma < b - \frac{1}{2}$ . In this case,  $W^N = 0$  according to Proposition 1, so that  $W^C > W^N$  and complete relocation is optimal.

(b) Let  $b - \frac{1}{2} < \gamma < 2b - \frac{1}{2}$ : The optimality condition for the national firm involves  $r = a - t$  and the resulting welfare level is given by  $t^2 \left( \frac{\gamma}{4} + \frac{1}{8} - \frac{b}{4} \right)$ . The resulting condition for  $W^C > W^N$  is

$$-\frac{bt^2}{4} < (a^2 - 2at) \left( \frac{\gamma}{4} + \frac{1}{8} \right) + \frac{\gamma}{4}(a^2 - 4F).$$

Using  $t < \frac{a - \sqrt{a^2 - 4F}}{2}$  and thus  $a^2 - 2at > 0$ , we derive that the inequality always holds.

(c) For  $2b - \frac{1}{2} < \gamma < \frac{-a + 8ab - 4bt}{4a - 2t}$ , the national firm is optimally regulated so that it produces for both countries. Again, we have  $W^C > W^N$  and optimality of  $C$ .

(d) Finally, for  $\frac{-a + 8ab - 4bt}{4a - 2t} < \gamma$ , the optimal regulation of the national firm is  $r = 0$ . It turns out that  $W^C > W^N$  and complete relocation is optimal in case  $\gamma < \frac{(t - 2a)(t + 2b(t - 2a))}{8F}$ , otherwise no relocation  $N$  is optimal, i.e.  $W^N > W^C$ .

(ii) We have to show that for  $t^1 < t < t^2$  the location choice is made as described in the proposition. We distinguish three cases:

(a) For  $\gamma < b - \frac{1}{2}$ , comparing  $W^P$  and  $W^C$  from Lemma 2 above and  $W^N$  from table 1 shows that  $C$  is optimal.

(b) For  $b - \frac{1}{2} < \gamma < 2b - \frac{a}{2(2a-t)}$ , comparison of the relevant expressions for  $W^N$  and  $W^P$  from above shows that always  $W^P > W^N$  and that thus  $N$  is never chosen. Comparing  $W^P$  and  $W^C$  leads to  $C$  being optimal for  $\gamma < \frac{b(t+\sqrt{a^2-4F})^2}{2at+2t\sqrt{a^2-4F}-4F} - \frac{1}{2}$  and  $P$  for the opposite (calculations are straightforward but tedious; cf. notes p22-25).

(c) For  $2b - \frac{a}{2(2a-t)} < \gamma$ , comparison of all three location choices is necessary. Pairwise comparison of the relevant expressions for welfare yields  $W^C > W^P \Leftrightarrow \gamma < \frac{b(t+\sqrt{a^2-4F})^2}{4a-2t} - \frac{1}{2}$ ,  $W^C > W^N \Leftrightarrow \gamma < \frac{2b(2a-t)^2-t(2a-t)}{8F}$ , and  $W^P > W^N \Leftrightarrow \gamma < \frac{2b(2t\sqrt{a^2-4F}+4at-3a^2-4F)}{2(2t\sqrt{a^2-4F}+2at-8F)} - \frac{(t^2+2t\sqrt{a^2-4F}-4F)}{2(2t\sqrt{a^2-4F}+2at-8F)}$ .

Combining all these conditions for optimality of a certain regime yields part (ii) of the proposition.

(iii) We have to show that, for  $t > t^2$ , there is complete relocation if and only if  $\gamma \leq \gamma^{C3} \equiv \frac{ba^2}{t(2a-t)} - \frac{1}{2}$ .

(a) For  $\gamma < b - \frac{1}{2}$ , Lemma 3(i) shows that the optimum in P is on the upper boundary of P and the welfare level is given by the expression for  $W^P$  given there. Comparison with the expression for  $W^C$  from Lemma 2 above shows that  $W^C > W^P$ .

(b) For  $\gamma > b - \frac{1}{2}$ , welfare under partial relocation is given by equation (14). It follows that  $W^C > W^P$  for  $b > \frac{(2\gamma+1)t(2a-t)}{2a^2}$  (as  $a^2 > 2at - t^2$ , this is compatible with the first condition on  $\gamma$ :  $\gamma > b - \frac{1}{2}$ ). Rearranging terms, this translates into  $C$  for  $b - \frac{1}{2} < \gamma < \frac{ba^2}{t(2a-t)} - \frac{1}{2}$  and  $P$  for  $\frac{ba^2}{t(2a-t)} - \frac{1}{2} < \gamma$  (as  $(a-t)^2 > 0$  we have  $b - \frac{1}{2} < \frac{ba^2}{t(2a-t)} - \frac{1}{2}$  and these ranges are possible).

## E The general model

We now show that the main insights of our analysis hold much more generally. We work with assumptions on the demand structure, the nature of regulation and the damage function which are compatible with our specific example. As before, we suppose there are two countries  $i = 1, 2$  and one firm, which originally has a plant in country 1. However, regulation in country 2 can be positive as well. We denote regulation levels as  $r_i$ . There are parameters capturing market demand  $a > 0$ , transportation costs  $t \geq 0$ , relocation costs  $F \geq 0$  and environmental damages  $b \geq 0$ . Let  $\theta = (a, b, t, F)$ . The firm has three options for location decisions, namely “no relocation” (“N”), i.e. it produces in country 1 only, “complete relocation” (“C”), i.e. it produces in country 2 only, and “partial relocation” (“P”), where production for country 1 takes place in country 1, production for country 2 takes place in country

two. We use the notation  $l(r_1, r_2; \theta)$  to denote locational decisions N, P or C.

## E.1 Profits and locational choices

We let  $\pi_{ij}(r_i; a, t)$  denote the optimal profits of a firm that serves country  $j$  from country  $i$  (gross of relocation costs); total gross profits of a firm having taken the locational decision  $l$  are thus  $\pi_l(r_i, r_j; a, t) \equiv \pi_{i1}(r_i; a, t) + \pi_{j2}(r_j; a, t)$ , with  $i = 1 = j$  for  $l = N$ ,  $i = 2 = j$  for  $l = C$ , and  $i = 1, j = 2$  for  $l = P$ . We let  $x_{ij}(r_i; a, t)$ ,  $x_l(r_i, r_j; a, t)$  denote the corresponding outputs.  $\Pi_l(r_i, r_j; a, t) = \pi_l(r_i, r_j; a, t) - F$  denotes net profits.

**Assumption 2** *Let  $i = 1, 2$ .*

- (a) *For  $i, j = 1, 2$  and all  $a > 0; t > 0$ , there exists an  $r^{\max} = r^{\max}(a, t)$  such that  $x_{ij}(r_i; a, t) \equiv 0$  and  $\pi_{ij}(r_i; a, t) \equiv 0$  for  $r_i \geq r^{\max}$ .*
- (b) *For  $r_i \leq r^{\max}$ ,  $\pi_{ij}$  and  $x_{ij}$  are (i) decreasing in  $r_i$  and (ii) increasing in  $a$ ; (iii) decreasing in  $t$  for  $i \neq j$  and independent of  $t$  for  $i = j$ . As long as  $x_{ij} > 0$ , the statements can be replaced with “strictly increasing” and “strictly decreasing”, respectively.*
- (c) (i)  $x_{ij}(r_i; a, t) \equiv x_{ji}(r_j; a, t)$  and  $\pi_{ij}(r_i; a, t) \equiv \pi_{ji}(r_j; a, t)$   
(ii)  $x_{1j}(r_1; a, 0) \equiv x_{2j}(r_2; a, 0)$  and  $\pi_{1j}(r_1; a, 0) \equiv \pi_{2j}(r_2; a, 0)$  for  $r_1 = r_2$ ,  
(d)  $x_{ij}$  and  $\pi_{ij}$  are continuous in all arguments.  
(e)  $\lim_{t \rightarrow \infty} \pi_{ij}(r_i; a, t) = \pi_{ji}(r_j; a, t) = 0$  (for  $i \neq j$ ),  
 $\lim_{a \rightarrow 0} \pi_{ij}(r_i; a, t) = 0$  for  $j = 1, 2$ .  
(f)  $x_{ii}(0; a, t) > 0$  and  $\pi_{ii}(0; a, t) > 0$ .

These assumptions are fairly general. (a) states that there is a prohibitive level of regulation; (b) stipulates that outputs and profits react to changes of regulation and to market parameters in the expected way; (c) requires that countries and firms are symmetric and differ only according to the type of regulation. Assumptions (d) and (e) are innocuous regularity properties; (f) states that outputs and profits are positive without regulation.

We show that the qualitative properties of Figure 1 hold if Assumption 2 does.

**Proposition 3** (i) *For all  $r_2 \geq 0$  and all  $\theta$ ,  $l(0, r_2; \theta) \neq C$ .*

(ii) *For all  $(r_2; \theta)$  there exists  $r_1^* > 0$  and  $t^* > 0$  such that  $\forall r_1 < r_1^*$  and  $\forall t < t^*$ ,  $l(r_1, r_2; \theta) = N$ .*

(iii) *For all  $(r_2; \theta)$  such that  $\pi_{22}(r_2; a, t) \geq F$  there exists  $r^* = r^*(r_2; \theta) > 0$  such that  $l(r_1, r_2; \theta) = C$  for  $r_1 > r^*$ .*

(iv) *For all  $(r_1, r_2, a, F)$  there exists a  $t^* > 0$  such that  $l(r_1, r_2; \theta) \neq P$  for  $t < t^*$ . If  $\pi_{22}(r_2; a, t) \geq F$ , then there is a  $t^{**}$  such that  $l(r_1, r_2; \theta) \neq N$  for  $t > t^{**}$ .*



**Proof:** (i) We have to show that serving country 1 from country 2 is never worthwhile for  $r_1 = 0$ , i.e.  $\pi_{11}(0; a, t) \geq \pi_{21}(r_2; a, t)$  for all  $r_2$ . By Assumption 2c(ii)  $\pi_{11}(0; a, 0) = \pi_{21}(0; a, 0)$ . By b(i)  $\pi_{21}(r_2; a, 0) \leq \pi_{21}(0; a, 0)$  for all  $r_2 \geq 0$ . Thus  $\pi_{11}(0; a, 0) \geq \pi_{21}(r_2; a, 0)$ . By b(iii)  $\pi_{11}(0; a, 0) = \pi_{11}(0; a, t)$  and  $\pi_{21}(r_2; a, 0) \geq \pi_{21}(r_2; a, t)$ . Hence  $\pi_{11}(0; a, t) \geq \pi_{21}(r_2; a, t)$ .  
(ii) By (cii)  $\pi_{11}(0; a, 0) = \pi_{21}(0; a, 0)$ , therefore by Assumption (bi),  $\pi_{11}(0; a, 0) \geq \pi_{21}(r_2; a, 0)$  for all  $r_2$ . Similarly,  $\pi_{12}(0; a, 0) \geq \pi_{22}(r_2; a, 0)$ . Because  $F > 0$ , therefore, relocation is never worthwhile for  $r_1 = t = 0$ . By continuity (d), the result also holds if  $r_1$  and  $t$  are sufficiently small.  
(iii) By Assumption 2(a),  $\pi_{1j}(r_1; a, t) = 0$  for  $r_1 \geq r^{\max}$  and  $j = 1, 2$ , so that production in country 1 is not worthwhile. However, as  $\pi_{22}(r_2; a, t) \geq F$  by assumption, a firm that relocates complete obtains a positive profit. Thus, complete relocation is worthwhile for  $r_1 \geq r^{\max}$ .  
(iv) First, we show that, if partial relocation is better than no relocation and  $t = 0$ , then complete relocation is better than partial relocation: Partial relocation necessarily requires  $\pi_{12}(r_1; a, 0) < \pi_{22}(r_2; a, 0)$ . By Assumption 2(c) and (biii),  $\pi_{12}(r_1; a, 0) = \pi_{11}(r_1; a, 0)$  and  $\pi_{22}(r_2; a, 0) = \pi_{21}(r_2; a, 0)$ . Therefore  $\pi_{11}(r_1; a, 0) < \pi_{21}(r_2; a, 0)$ , so that serving country 1 from abroad is more profitable than serving it from home. By continuity (assumption 2d), there then exists a  $t^* > 0$  such that complete relocation is optimal for  $t < t^*$ . Fix  $r_2, a, F$  and  $t$ . By Assumption 2(e),  $\lim_{t \rightarrow \infty} \pi_{12}(r_1; a, t) = 0$ . Because  $\pi_{22}(r_2; a, t) \geq F$ , partial or complete relocation is optimal for sufficiently high  $t$  and no relocation is never chosen.

The proposition reflects the relocation structure of our specific model in a more general context. As to (i), complete relocation does not occur when there is no regulation in the home country.<sup>31</sup> (ii) says that, if regulation and transportation costs are small, no relocation occurs. By (iii), provided that foreign country regulation is not too strict to prevent positive profits net of relocation costs, complete relocation occurs for sufficiently high regulation in the home country. (iv) states that whether relocation is partial or complete depends on the interaction between regulation and transportation costs: For low transportation costs, partial relocation is never optimal, while for higher transportation costs partial relocation can be optimal and no relocation is never chosen.

---

<sup>31</sup>Note that in this case partial relocation may occur due to high transportation costs.

## E.2 The choice of regulation

We now introduce additional assumptions so that we can address the choice of regulation.

**Assumption 3** (a) *The regulator maximizes a weighted sum of consumer surplus (minus damages) and profits.*

(b) *Consumer surplus is a strictly increasing function of  $x_i$ .*

(c) *Damages are continuous, weakly increasing functions of  $x_i$  and  $b$ . For  $b > 0$ , they are strictly increasing in  $x_i$ ; for positive  $x_i$ , they are strictly increasing in  $b$ . For  $b = 0$ , damages are 0 for all  $x_i$  and hence the optimal regulation is 0.*

(d) *For national and multinational firms, the optimal regulation is a continuous function of all parameters as long as no change of location is induced. As  $b \rightarrow \infty$ , the optimal regulation involves  $x_i = 0$ .*

We now ask to which extent the comparative analysis (Result 1) for the pure consumer surplus case generalizes.

**Proposition 4** *Suppose  $\gamma = 0$ .*

(a) *Fix  $a$ ,  $F$  and  $r_2$ .*

(i) *For every level of transportation costs, there exists a value of  $\bar{b}$  such that neither the national nor the multinational firm produces any output for  $b > \bar{b}$ .*

(ii) *If  $t$  is sufficiently small, but positive, there exists  $\underline{b} > 0$  such that both firms produce the same output level for  $b < \underline{b}$ .*

(b) *Fix  $a$  and  $F$ . Suppose  $r_2$  is sufficiently small. (i) If  $t$  is sufficiently small, there exist  $b_*$  and  $b^*$  such that  $b_* < b^*$  and multinational firms produce less home-country output than national firms for  $b \in (b_*, b^*)$ . (ii) If  $t$  is sufficiently large, there exist  $\tilde{b}$  such that multinational firms produce less home-country output than national firms for  $b < \tilde{b}$ .*

**Proof:** (a) (i) is just a restatement of Assumption 3(d): As  $b \rightarrow \infty$ ,  $r_i$  becomes so high for both firms that there is no output. (ii) First consider the multinational firm. Assume it has completely relocated. Fix  $t > 0$ , so that the output of the multinational firm is smaller than if there is no relocation by Assumption 2(biii) and hence complete relocation involves a loss in consumer surplus which is independent of  $b$ . By continuity of damages in  $b$  and in outputs (Assumption 3(d)), the damage reduction from relocation approaches 0 as  $b$  does. Thus, for every  $t > 0$  there is a critical value of  $b$  below which complete relocation is not optimal.

Moreover, for any given level of  $a$ ,  $F$  and  $r_2$ , if  $b$  is sufficiently small, the environmental gains from regulation are small by Assumption 3(c). By Assumption 2(b) and 3(b), the costs of regulation in terms of reduced consumer

surplus are positive and independent of  $t$ . Hence  $r_1$  becomes arbitrarily small as  $b$  does. If  $t$  is also sufficiently small, the multinational firm's gains from reduced transportation costs and regulation under partial relocation are small by continuity of profits in  $r_i$  and  $t$  (Assumption 2(d)), so that partial relocation is not worthwhile (due to the fixed, positive relocation costs involved). Thus, there is no relocation.

For the national firm, for sufficiently small  $b$ ,  $r_i$  also becomes arbitrarily small. By Assumption 2(f), home-country profits are positive. If  $t$  is also sufficiently small, continuity of profits (Assumption 2(d)) and symmetry (Assumption 2(c)) imply that it is worthwhile to serve the foreign market as well. Thus, both firms are serving both markets and face the same regulation to which they react in the same way.

(b) (i) Fix all parameters except  $b$ . By Assumption 3(d), regulation optimally reduces outputs to zero as  $b \rightarrow \infty$ . For  $b = 0$ , there is no regulation and the firm has a positive home country output by Assumption 2(f). By continuity of optimal regulation in  $b$  and continuity of outputs in  $r_i$ , the intermediate value theorem implies that there exists a minimal  $\bar{b} \geq 0$  such that the production of the national firm is optimally reduced to 0. By continuity of  $x_{ji}$  the optimal regulation of the multinational firm at  $\bar{b}$  involves complete relocation with positive imports of country  $i$  if  $t$  and  $r_j$  are sufficiently small: While the advantage from reducing pollution by constraining either firm to producing for the home country is the same, the multinational firm still generates a positive consumer surplus whereas the national firm does not.

(ii) Let  $b$  be sufficiently small. By continuity of damages in outputs and  $b$ , the benefits from regulation become arbitrarily small. Therefore the optimal regulation level  $r_1$  is small for both the national and the multinational firm. According to Assumption 2(e), for any  $r_1$  there exists a critical value of  $t$  such that there is partial relocation of the multinational above this critical level. The regulation of the national firm is also close to zero. However, the multinational firm produces for both countries. Because outputs are continuous in regulation levels, the multinational firm produces less than the national firm.

Result a) identifies the conditions under which both firms are regulated so that they choose the same output levels. In qualitative terms, the regions where this is the case correspond to those shaded grey in Figure 2. Result b) uncovers the two forces because of which the multinational firm might produce less than the national firm: Result (i) reflects the intuition that for low transportation costs and intermediate values of damages, regulators want to close down home production of the multinational firm, because supply from abroad is not costly. Result (ii) reflects the effect that for large transportation costs and low damages multinational firms will not produce in the home

country whereas national firms still do.

However, note that we have not included a generalization of the result that, for large transportation costs and intermediate values of the damage parameter, the multinational firm produces more output. While the logic of the result in Section 6 that multinational firms pollute more than national firms for some parameter regions is quite general, it merely implies that, *if* there are some points in the partial relocation regime where it is optimal to prevent exports of the national firm, then the multinational firm will be regulated less for these values and produce larger outputs. While there are large parameter regions where this logic is confirmed, there are also parameter regions where this is not the case.

## References

- Aidt, T., Alborno, F., 2011. Political regimes and foreign intervention. *Journal of Development Economics* 94, 192-201.
- Bhagwati, J.N., 1987. VERs, Quid Pro Quo and VIEs: Political-Economy-Theoretic analyses. *International Economic Journal* 1, 1-14.
- Bhagwati, J.N., Dinopoulos, E., Wong, K., 1992. Quid Pro Quo foreign investment. *American Economic Review* 82, 186-190.
- Bellettini, G., Kempf, H., 2013. Why not in your backyard? On the location and size of a public facility. *Regional Science and Urban Economics* 43, 22-30.
- Brunnermeier, S.B., Levinson, A., 2004. Examining the evidence on environmental regulations and industry location. *Journal of Environment and Development* 13, 6-41.
- Cole, M., Elliott, R., Fredriksson P., 2006. Endogenous pollution havens: Does FDI influence environmental regulations? *Scandinavian Journal of Economics* 108, 157-178.
- Elliott, R.J.R., Zhou, Y., 2013. Environmental regulation induced foreign direct investment. *Environmental and Resource Economics* 15, 75-87.
- Erdogan, A.M., 2013. Foreign direct investment and environmental regulations: A survey. *Journal of Economic Surveys*, forthcoming.  
doi: 10.1111/joes.12047.
- Fredriksson, P., 2000. The siting of hazardous waste facilities in federal systems. *Environmental and Resource Economics* 55, 141-158.
- Fredriksson, P., List, J.A., Millimet, D.A., 2003. Bureaucratic corruption, environmental policy and inbound U.S. FDI: Theory and evidence. *Journal of Public Economics* 87, 1407-1430.

- Fredriksson, P., Wollscheid, J.R., 2008. The political economy of investment: The case of pollution control technology. *European Journal of Political Economy* 24, 53-72.
- Gawande, K., Krishna, P., Robbins, M.J., 2006. Foreign lobbies and U.S. trade policy. *Review of Economics and Statistics* 88, 563-571.
- Grossman, G.M., Helpman, E., 1994. Protection for sale. *American Economic Review* 84, 833-850.
- Grossman, G.M., Helpman, E., 1996. Foreign investment with endogenous protection. In: Feenstra, R.C., Grossman, G.M., Irwin, D.A. (Eds.), *The Political Economy of Trade Policy*. MIT Press, Cambridge MA, pp. 199-223.
- Grossman, G.M., Helpman, E., 2002. *Interest Groups and Trade Policy*. Princeton University Press, Princeton.
- Hansen, W.L., Mitchell, N.J., 2000. Disaggregating and explaining corporate political activity: Domestic and foreign corporations in national politics. *American Political Science Review* 94, 891-903.
- Hillman, A.L., 1989. *The political economy of protection*. Harwood Academic Publishers, Chur.
- Hillman, A.L., Ursprung, H.W., 1993. Multinational firms, political competition, and international trade policy. *International Economic Review* 34, 347-363.
- Konishi, H., Saggi, K., Weber, S., 1999. Endogenous trade policy under foreign direct investment. *Journal of International Economics* 49, 289-308.
- Levinson, A., Taylor, M.S., 2008. Unmasking the pollution haven effect. *International Economic Review* 49, 223-254.
- Markusen, J., Morey, E., Olewiler, N., 1993. Environmental policy when market structure and plant locations are endogenous. *Journal of Environmental Economics and Management* 24, 69-86.
- Markusen, J., Morey, E., Olewiler, N., 1995. Competition in regional environmental policies when plant locations are endogenous. *Journal of Public Economics* 56, 55-77.
- Motta, M., Thisse, J.-F., 1994. Does environmental dumping lead to delocation? *European Economic Review* 38, 563-576.
- Neven, D., Röller, L.H., 2005. Consumer surplus vs. welfare standard in a political economy model of merger control. *International Journal of Industrial Organization* 23, 829-848.
- Potters, J., Sloof, R., 1996. Interest groups: A survey of empirical models that try to assess their influence. *European Journal of Political Economy* 12, 403-442.

- Rauscher, M., 1995. Environmental regulation and the location of polluting industries. *International Tax and Public Finance* 2, 229-44.
- Schleich, J., 1999. Environmental quality with endogenous domestic and trade policies. *European Journal of Political Economy* 15, 53-71.
- Stoyanov, A., 2009. Trade policy of a free trade agreement in the presence of foreign lobbying. *Journal of International Economics* 77, 37-49.
- Sturm, D. M., 2003. Trade and the environment: A survey of the literature. In: Marsiliani, L., Rauscher, M., Withagen, C. (Eds.), *Environmental Policy in an International Perspective*. Kluwer Academic Publishers, Dordrecht, pp. 119-149.